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भारतीय मानक

बैराज और वियर के लिए उपसतह का अन्वेषण — रीति संहिता

(पहला पुनरीक्षण)

Indian Standard

SUBSURFACE EXPLORATION FOR BARRAGES AND WEIRS — CODE OF PRACTICE

(First Revision)

ICS 93.020

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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Price Group 4

Geological Investigations and Subsurface Exploration Sectional Committee, WRD 05

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Geological Investigations and Subsurface Exploration Sectional Committee had been approved by the Water Resources Division Council.

This standard was first published in 1992. This revision has been done in view of changes in technology and in field experience.

The purpose of subsurface exploration is to determine the extent and nature of the principal soil strata, the depth of ground water and to obtain samples of the various soils for identification. In addition, samples are often required for laboratory tests to determine the physical properties of the soil. Adequate investigation is an important requisite for the proper design. Subsurface exploration forms an important part of these investigations. It is not possible to lay down the required extent of exploration to cover all types of cases. This standard provides guidelines for planning the exploratory work through various stages of project development. These recommendations may have to be modified for individual projects depending upon the site conditions, heterogeneity of foundation formations and on conditions peculiar to each project.

It has been assumed in the formulation of this standard that the execution of its provisions is entrusted to appropriately qualified and experienced people, for whose guidance it has been formulated.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

SUBSURFACE EXPLORATION FOR BARRAGES AND WEIRS — CODE OF PRACTICE

(First Revision)

1 SCOPE

1.1 This standard gives guidance on the type, extent and details of subsurface exploration needed in connection with barrages and weirs.

1.2 The term subsurface exploration, as used herein, covers all types of exploration connected with determination of the nature and extent of soil and/or rock below the natural ground surface at or near barrage/weir sites.

2 REFERENCES

The standards listed in Annex A contain provisions which through reference in this text constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on these standards are encouraged to investigate the possibility of applying the most recent editions of the standards indicated in Annex A.

3 PROGRAMME OF EXPLORATION

3.1 A programme of exploration should be formulated before field work is started. The engineer responsible for preparation of designs and specifications should review the exploratory programme in consultation with a geologist before work is initiated.

3.2 The programme should show the locations of proposed test holes, as well as the extent and the kind of data to be secured. The programme should show the order in which explorations are to be made, so that the most questionable and the most critical areas are explored first.

4 GENERAL CONDITIONS

4.1 The type and extent of exploration should be commensurate with the size and importance of the project. This should be neither too little, resulting in inadequate data, nor too much resulting in excessive cost and time.

4.2 All subsurface explorations are to be preceded by geological mapping on 1:1 000 or 1: 5 000 scale for canal alignment covering 100 m on either sides.

4.3 The exploration should lead to an appraisal of the general subsurface conditions throughout the area of the project as well as an evaluation of broad aspects of the foundation conditions of alternative sites selected.

4.4 The specific objectives of a subsurface exploration, which are to be determined, are as follows:

a) Types of different soil and rock masses that exist in the foundation of main barrage/weir, abutment, divide wall, flared wall, etc, and in the head regulator as well as silt excluder portion of the barrage.

b) The location, sequence, thickness and areal extent of each soil/rock stratum, including a description and classification of the soils and their structure, stratification in the undisturbed state, significant geological or other structural features, such as buried channels, seams, joints, fissures, faults, shear zones, etc, and mineral and chemical constituents.

c) The depth and type of bed rock as well as the locations, sequence, thickness, areal extent, attitude, depth of weathering, permeability and description of rock in each rock stratum within the depth of exploration.

d) The characteristics of the ground water, including whether the water table is perched or normal, direction of flow of ground water, depth of and pressure in artesian zones, and quality of dissolved salts present in the ground water.

e) Engineering and index properties of the overburden and bed rock.

5 STAGES OF EXPLORATION

5.1 The purpose of soil investigation is to obtain information relating to foundation conditions commensurate with the magnitude and type of structure involved and with the stage of the project.

5.2 Normally, a project is developed in the stages as detailed in **5.2.1** to **5.2.3**.

5.2.1 *Reconnaissance or Pre-feasibility Stage*

5.2.1.1 Reconnaissance is the inventory of possible sites to determine the kind of geological and engineering problems that could be encountered on different sites. Investigations should cover the broad aspects of the local structures and foundation conditions and the relation of these to the geology of the region.

The data secured in the reconnaissance stage is primarily descriptive. Data already available is summarized and a visual examination of the project is made. Soil properties are based largely on visual classification. The field work is usually done by a geologist and/or engineer. The investigation during the reconnaissance stage should lead to an appraisal of the general geological conditions throughout the area of the project and alternative sites. The appraisal should define major advantages and disadvantages of the subsurface strata and material deposits at the alternative sites with reasonable certainty. The most desirable site may be investigated further by additional surface examination and testing, if required.

5.2.2 *Preliminary Investigation or Feasibility Stage*

5.2.2.1 In the feasibility stage, the data is primarily qualitative. Limited exploration is done to confirm the geological interpretation or to develop a new interpretation, if necessary. Pertinent conditions are developed and their dimensions are approximately determined. The properties of soil are determined by index tests. The field work is done jointly by a geologist and an engineer. The object of the feasibility stage of an investigation is to confirm or expand the work done in the reconnaissance stage in order that an adequate estimate of cost may be prepared for the project. This cost can be compared to the benefits to determine whether the project is economically justified. The purpose of a feasibility investigation is to establish a factual background for a design and an estimate that serve as a basis for seeking authorization and an advance of funds for construction.

5.2.2.2 For structures concerned with storage like barrages and weirs, the problem of water loss should always be thoroughly investigated in the feasibility stage. Unless areas where water loss may be expected are concentrated, the cost of the required treatment will nearly always have a significant influence on the total project cost. It is essential, therefore, that reservoirs be examined to determine whether water loss is a potential problem. The areas of water loss should be delineated and magnitude of the water loss should be estimated.

5.2.2.3 This stage of exploration includes the following:

a) Exploration by test pits, trenches and sometimes by drifts and shafts (*see* IS 4453).
b) Exploration by geophysical methods.
c) Exploration by drilling using coring and non-coring methods or by other boring methods.

5.2.2.4 The following investigations should be carried out in alluvial foundations:

a) Borings should be made at suitable locations in the barrage or weir area and detailed borelogs prepared giving details of various strata encountered in accordance with IS 4464. The spacing of bore holes should be planned in such a manner so as to cover the foundations of various structures.
b) For sandy foundations, dynamic and static penetration tests should be performed below each structure (abutments, piers, etc) and in each bay to estimate bearing pressures, likely settlement and necessity of settlement joints. For boulder strata, plate bearing tests shall be required.
c) Soil classification, unit weight of soil, angle of internal friction of soil, void ratio and specific gravity up to foundation level and grain size distribution, etc.
d) In case of clayey and silty foundation material undisturbed samples should be collected and analyzed to determine the cohesion, unconfined compressive strength, moisture content, dry density, sensitivity and consolidation characteristics. Static cone penetration test as per IS 4968 (Part 3), may also be carried out if deemed necessary.
e) Modulus of subgrade reaction in case of raft foundation at the proposed foundation level shall be obtained by conducting *in-situ* tests in accordance with IS 9214, in case it is not feasible to determine the modulus of subgrade reaction at site, the values given in IS 2950 (Part 1) may be adopted for design purposes, depending on the type of soil.

5.2.3 *Detailed Investigation or DPR Stage*

5.2.3.1 In the detailed investigation or DPR stage, the data is primarily quantitative and specific. Sufficient exploration is done to establish conditions at all critical points. Engineering properties are determined for various soil types. The work is done primarily by an engineer with geological assistance as required. The purpose of the specification stage of an investigation is to provide data from which designs for construction of various features of the project can be made.

5.2.3.2 Investigations at this stage would comprise of the following:

a) Exploration by test pits, trenches and sometimes by drifts and shafts.

b) Exploration by geophysical methods.

c) Exploration by drilling using coring and non-coring methods or by other boring methods.

d) Determination of the depth to water table and evaluation of field permeability, observation of temperature, pressure and discharge of springs met at the surface or in exploratory borings, trenches, etc. Observations of water table in the area adjacent to the location of the barrage should also be carried out for three dimensional electrical analogy study.

e) Field penetration and field density tests in overburden.

f) Laboratory tests on representative samples and undistributed samples for the determination of engineering and index properties of the overburden material.

g) The likelihood of higher levels in the pond leading to rise of water table with consequent water logging in the adjacent area should also be investigated for suitable measure.

h) If rocky strata is available at a shallow depth, trial pits may be excavated to determine the depth of over burden, loose deposits, depth of weathered zone and extent of joints and fissures. The *in-situ* permeability should also be checked so that the necessity, or otherwise of grouting to avoid excessive seepage losses, etc, can be assessed.

j) The depth of impervious layer should be located in the entire barrage and head regulator area. The investigation should also ascertain whether the impervious boundary is horizontal sloping up towards the upstream or downstream. An impervious boundary sloping up on the downstream will cause constriction of seepage and should be avoided by shifting the location of the barrage slightly upstream, taking help of model studies, if necessary.

k) Use of geophysical methods to define in greater detail the subsurface conditions, such as the depth to bed rock or depth to water table. During this stage use of suitable bore hole geophysical methods, as and when required, may be found advantageous to define particular characteristics of overburden and bed rock.

m) Intensive exploration by additional drilling and pitting (trenches and shafts where found necessary) of the foundation to determine distribution and characteristics of different types of foundation materials in relation to specific design features.

n) Determination of the permeability of foundation material by suitable tests.

p) Ascertaining the groutability of foundations through trial grouting of specified reaches.

q) Special field tests like tests to determine liquefaction characteristics and field shear tests where found necessary.

5.2.3.3 The following investigations should be carried out in alluvial foundations:

a) Borings should be made at suitable locations in the barrage or weir area and detailed borelogs should be prepared giving details of various strata encountered in accordance with IS 4464. The spacing of bore holes should be planned in such a manner so as to cover the foundations of various structures.

b) For sandy foundations, dynamic and static penetration tests should be performed below each structure (abutments, piers, etc) and in each bay to estimate bearing pressures, likely settlement and necessity of settlement joints. For boulder strata, plate bearing tests shall be required.

c) Soil classification, unit weight of soil, angle of internal friction of soil, void ratio and specific gravity up to foundation level and grain size distribution, etc.

d) In case of clayey and silty foundation material undisturbed samples should be collected and analyzed to determine the cohesion, unconfined compressive strength, moisture content, dry density, sensitivity and consolidation characteristics. Static cone penetration test as per IS 4968 (Part 3), may also be carried out, if deemed necessary.

e) Modulus of subgrade reaction in case of raft foundation at the proposed foundation level shall be obtained by conducting *in-situ* tests in accordance with IS 1888, in case it is not feasible to determine the modulus of subgrade reaction at site, the values given in IS 2950 (Part 1) may be adopted for design purposes, depending on the type of soil.

5.2.3.4 The results of this stage subsurface exploration should be incorporated in a report. At this stage, background materials can be summarized, but the detailed work done should be fully covered with drill logs and cross sections showing geological interpretation.

5.2.4 *Construction Stage*

Construction stage exploration shall aim at making available data generally for the evaluation of specific foundation preparation and treatment. In case, after actual excavation, it is found that the properties of foundation material vary too much, then, in each bay, information shall be gathered at least at 3 points. A complete record of the foundation features shall be maintained at this stage. This is essential for the solution of post construction problems, if any. Foundation grade geotechnical mapping on 1:100 scale should be done.

6 LOCATION, SPACING AND DEPTH OF EXPLORATION

6.1 Boreholes should be sunk at specified intervals covering the barrage or weir area and appurtenant structures. The location of borings shall be correctly marked and numbered on the survey sheets. These borings should be carried to the hard rock level or to a depth of 20 m to 25 m below the deepest river bed level depending on the strata and structure (pier, floor, abutment, guide bund, wing wall, divide wall, etc). Trial pits may be excavated to determine the depth of overburden and loose deposits, if shallow. In case of large depth of overburden underlain by rock and overburden comprising of boulders where ordinary boring methods may prove inadequate, geophysical methods may be employed to locate the rock surface. In sub-mountainous region where the overburden is sand mixed with cobbles and gravel or has a compact layer of cobbles and shingles, boreholes may be sunk by kelly grabs.

7 METHODS OF EXPLORATION

The following methods may be used for subsurface exploration for barrages/weirs:

a) Pits and trenches;
b) Borings:
   1) Auger boring, and
   2) Rotary drilling,
c) Drifts and shafts;
d) Geophysical methods;
e) Field tests *in-situ*; and
f) Laboratory tests.

7.1 Exploration by Pits and Trenches

Test pitting is an, effective means of exploring and sampling earth foundations. Its use facilitates inspection, sampling and carrying out of density tests. The location of pits should preferably be decided in consultation with a geologist. They are useful for investigating the nature of overburden in foundation. The exploration should be carried out as per IS 4453.

7.2 Exploration by Borings

Exploration by borings may be made by several methods, depending upon the nature of sub-soil strata, as detailed in IS 1892 and IS 6926.

7.3 Exploration by Drifts and Shafts

Drifts and shafts are normally employed to explore at depth the continuity or character of subsurface formations. They are most frequently used for the investigation of fault or shear zones, buried channels and suspected places of weakness in foundation, abutments and beneath steep slopes or back of cliff like faces to determine the extent of weathering, slump zone and bed rock configuration in areas of fossil valleys. When carrying out exploration by drifts and shafts reference should be made to IS 4453.

7.4 Geophysical Methods

In case of large depths of overburden comprising of large size boulders, where ordinary boring methods may prove inadequate, geophysical methods may be employed to locate the rock surface. Geophysical procedures involve measurement of variations of magnetic or gravitational forces or conductivity of electric current. Seismic surveys have also been used on a reconnaissance basis, to determine approximate depths to the rocks and to locate buried channels. Electric resistivity surveys have been used to determine approximate depths of weathering of bed rocks and to fix the extent of buried gravel deposits.

For test results to be reliable, it is necessary that correlation be made locally with exploration made by borings.

7.5 *In-Situ* Field Tests

Field tests *in-situ* are those in which the material is tested without actual removal from its existing position. Those applicable to barrages/weirs are the following:

a) Strength tests;
b) Permeability tests;

c) Measurement of density of foundation material;
d) Tests for liquefaction characteristics;
e) Modulus of subgrade reaction at the proposed foundation level by conducting *in-situ* tests in accordance with IS 9214; and
f) Determination of safe bearing capacity by conducting *in-situ* test in accordance with IS 1888.

The necessity and the number of each type of tests to be conducted depends on the foundation material and its degree of variability.

7.5.1 *Strength Tests*

Detailed foundation investigation comprising of penetration tests and shear tests should be conducted in the barrage and appurtenant structure areas to mark out soft foundation area, if any, for special treatment, or for examining the possibility of avoiding it by suitably changing the layout (*see* IS 2131 and IS 4434).

7.5.2 *Permeability Tests*

Field permeability tests should be carried out to assess the order of seepage losses from the pond and thereby, dewatering requirements. If the latter works out to be excessive, studies should be carried out to reduce excavation requirements by resorting to a reinforced raft structure. Permeability is usually determined by *in-situ* pumping in and pumping out tests [*see* IS 5529 (Part 1) and IS 5529 (Part 2)].

7.5.3 *Measurement of Density of Foundation Material*

In-situ measurement of density of foundation material is in stability analysis. It also affords information on the state of compaction and to decide whether further compaction is needed [*see* IS 2720 (Part 28), IS 2720 (Part 29), IS 2720 (Part 33) and IS 2720 (Part 34)].

7.5.4 *Tests for Liquefaction Characteristics*

Blasting test is often performed in foundations of saturated loose non-cohesive soils mainly for assessment of the likely chances of liquefaction and settlement in the event of earthquake, and also as a prototype test for studying the efficacy of blasting as a means of compaction of non-cohesive soils, where compaction is considered necessary or desirable.

The test consists in blasting charges of different strength and at different depths and measuring induced accelerations, pore pressure rise, and settlement or heave at different points.

7.6 Laboratory Tests

7.6.1 To take undisturbed samples from core holes, properly designed sampling tools shall be used. These differ for cohesive and non-cohesive soils and rocks. Special samplers like piston samplers and/or freezing or grouting techniques may have to be employed in cases where samples are to be collected from cohesionless sand which cannot be sampled by ordinary equipment and methods.

7.6.2 Sufficient quantity of representative undisturbed samples shall be collected for carrying out the necessary tests.

7.6.3 While boring small diameter bore holes in foundation area, the total material recovered as core should be collected and stored in core boxes (*see* IS 4078). Samples of soil and rock should be collected and preserved in sealed joint jars to preserve their natural water content. Samples should be representative of the material as it is found in the area.

7.6.4 In the exploration of materials in foundations, the excavation from which are in substantial quantities and may be used in embankment construction, samples should be collected representative of each stratum in a volume sufficient to provide about 35 kg of material passing a 4.75 mm IS Sieve. Material smaller than 75 mm should not be removed from this sample.

7.6.5 Samples collected in the process of routine explorations are not as a rule, satisfactory for determination of properties of soil or rock enmasse, in its natural condition. For this purpose, samples should be collected of material unaffected by seasonal climatic influence from large diameter bore holes (100 mm to 150 mm diameter minimum) or from the bottom of open pits.

7.6.6 The tests for soils are given in Table 1 and for rock in Table 2 with reference to relevant Indian Standards.

7.6.7 Chemical analysis of river water and ground water including determination of *p*H value [*see* IS 3025 (Part 11)] may be done to assess the effects of water such as corrosion, on underground, or other hydromechanical installations and leaching of salts from foundation strata or deposition of salt from the percolating underground water.

8 RECORDING AND REPORTING OF DATA

8.1 General

Information collected from the explorations mentioned should be recorded and presented in a concise and systematic manner, suitable for

Table 1 Laboratory Tests for Soils
(*Clause* 7.6.6)

Sl No. (1)	Property to be Tested (2)	Indian Standard (3)
i)	Visual and manual examination	IS 1498
ii)	Natural moisture content	IS 2720 (Part 2)
iii)	Liquid and plastic limits	IS 2720 (Part 5)
iv)	Grain size analysis	IS 2720 (Part 4)
v)	Permeability	IS 2720 (Part 17)
vi)	Consolidation properties	IS 2720 (Part 15)
vii)	Swelling tests	IS 2720 (Part 40) and IS 2720 (Part 41)
viii)	Unconfined compressive strength	IS 2720 (Part 10)
ix)	Direct shear test	IS 2720 (Part 13)
x)	Triaxial shear test	IS 2720 (Part 11) and IS 2720 (Part 12)
xi)	Compaction test	IS 2720 (Part 38)
xii)	Relative density (Density index)	IS 2720 (Part 14)
xiii)	Chemical analysis:	
	a) Total soluble solids	IS 2720 (Part 21)
	b) Organic matter	IS 2720 (Part 22)
	c) Calcium carbonate	IS 2720 (Part 23)
	d) *p*H value	IS 2720 (Part 26)
	e) Total soluble sulphates	IS 2720 (Part 27)

Table 2 Laboratory Tests for Rock
(*Clause* 7.6.6)

Sl No. (1)	Property to be Tested (2)	Indian Standard (3)
i)	Rock properties	IS 7292
ii)	Deformation modulus	IS 7317
iii)	Shear test	IS 7746
iv)	Point load strength index	IS 8764
v)	Unconfined compressive strength	IS 9143
vi)	Modulus of elasticity	IS 9221
vii)	Shear strength of rock joint	IS 12634

convenient use in the form of maps, subsurface sections, etc. The locations of sections and points of exploration should be clearly indicated on a map. Pits, trenches, drifts, shafts, different types of bore holes, etc, should be indicated on location maps using suitable symbols in accordance with IS 7422 (Part 1), IS 7422 (Part 2), IS 7422 (Part 3), IS 7422 (Part 4) and IS 7422 (Part 5).

Sections showing subsurface conditions believed to exist should be prepared. The locations of the sections should be selected in such a manner that the information is presented in the best possible manner. With different information like type, nature and continuity of subsurface material, natural moisture content, density, permeability, etc, shown for different strata, the sections present very useful data for design studies.

8.1.1 The scales used for maps should be in accordance with IS 15686.

8.2 Logging of Pits, Trenches and Holes

8.2.1 *Location*

Every pit, trench and hole should be definitely located on a map by being tied to a coordinate grid system. The top elevations should be recorded, as well as the inclination of the inclined holes.

8.2.2 *Identification*

The holes, pits, etc, should all be numbered normally in the order in which they are drilled and with suitable symbols as given in the relevant Indian Standards.

8.2.3 *Logs*

A standard and exhaustive log form should be used giving as much information as possible (*see* IS 4453 and IS 4464).

8.2.4 *Description of Soils*

The soils should be described in the logs and in the records according to IS 1498.

8.2.5 *Description of Rock Cores*

The description of the rock core should include its typical name followed by data on its lithologic and structural features, physical conditions, and any special geologic, mineralogic or physical features pertinent to interpretation of the subsurface conditions (*see* IS 4464).

ANNEX A

(*Clause* 2.1)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
1498 : 1970	Classification and identification of soils for general engineering purposes (*first revision*)
1888 : 1982	Method for load test on soils (*second revision*)
1892 : 1979	Code of practice for subsurface investigations for foundations (*first revision*)
2131 : 1981	Methods of standard penetration test for soils (*first revision*)
2720	Methods of test for soils :
(Part 2) : 1973	Determination of water content (*second revision*)
(Part 4) : 1985	Grain size analysis (*second revision*)
(Part 5) : 1985	Determination of liquid and plastic limit (*second revision*)
(Part 10) : 1991	Determination of unconfined compressive strength (*first revision*)
(Part 11) : 1993	Determination of the shear strength parameters of a specimen tested in unconsolidated undrained triaxial compression without the measurement of pore pressure
(Part 12) : 1981	Determination of the shear strength parameters of soil from consolidated, undrained triaxial compression test with measurement of pore water pressure (*first revision*)
(Part 13) : 1986	Direct shear test (*second revision*)
(Part 14) : 1983	Determination of density index (relative density) of cohesionless soils (*first revision*)
(Part 15) : 1965	Determination of consolidation properties (*first revision*)
(Part 17) : 1986	Laboratory determination of permeability (*first revision*)
(Part 21) : 1977	Determination of total soluble solids (*first revision*)
(Part 22) : 1972	Determination of organic matter (*first revision*)
(Part 23) : 1976	Determination of calcium carbonate (*first revision*)
(Part 26) : 1987	Determination of pH value (*second revision*)
(Part 27) : 1977	Determination of soluble sulphates (*first revision*)
(Part 28) : 1974	Determination of dry density of soils in place by the sand replacement method (*first revision*)
(Part 29) : 1975	Determination of dry density of soils in place, by the core-cutter method (*first revision*)
(Part 33) : 1971	Determination of density of soil in place by the ring and water replacement method
(Part 34) : 1972	Determination of density of soil in place by rubber balloon method
(Part 38) : 1976	Compaction control test (Hilf method)

IS No.	*Title*
(Part 40) : 1977	Determination of free swell index of soils
(Part 41) : 1977	Determination of swelling pressure of soils
2950 (Part 1) : 1981	Code of practice for design and construction of raft foundations: Part 1 Design (*second revision*)
3025 (Part 11) : 1983	Methods of sampling and test (physical and chemical) for water and waste water: Part 11 *p*H value (*first revision*)
4078 : 1980	Code of practice for indexing and storage of drill cores (*first revision*)
4434 : 1978	Code of practice for *in-situ* vane shear test for soils (*first revision*)
4453 : 1980	Code of practice for exploration by pits, trenches, drifts and shafts (*first revision*)
4464 : 1985	Code of practice for presentation of drilling information and core description in foundation investigation (*first revision*)
4968 (Part 3) : 1976	Method for subsurface sounding for soils: Part 3 Static cone penetration test (*first revision*)
5529	Code of practice *in-situ* permeability test :
(Part 1) : 1985	Test in overburden (*first revision*)
(Part 2) : 2006	Test in rock (*second revision*)
6926 : 1996	Code of practice for diamond core drilling for site investigation for river valley projects
7292 : 1974	Code of practice for *in-situ* determination of rock properties by flat jack
7317 : 1993	Code of practice for uniaxial jacking test for deformation modulus of rock
7422	Symbols and abbreviations for use in geological maps, sections and subsurface exploratory logs:
(Part 1) : 1974	Abbreviations
(Part 2) : 1974	Igneous rocks
(Part 3) : 1974	Sedimentary rocks
(Part 4) : 1985	Metamorphic rocks
(Part 5) : 1992	Line contacts and structural features
7746 : 1991	Code of practice for *in-situ* shear test on rock
8764 : 1998	Method of determination of point load strength index of rocks
9143 : 1979	Method of determination of unconfined compressive strength of rock materials
9214 : 1979	Method for determination of modulus of sub-grade reaction (*k*-value) of soils in the field
9221 : 1979	Method for the determination of modulus of elasticity and Poisson's ratio of rock materials in uniaxial compression
12634 : 1989	Rock joints-direct shear strength—Laboratory method of determination
4453 : 1980	Exploration by pits, trenches, drifts and shafts —Code of practice(*first revision*)
15686 : 2006	Recommendations for preparation of geological and geotechnical maps for river valley projects

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Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards: Monthly Additions'.

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Amendments Issued Since Publication

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Regional Offices:		Telephones
Central :	Manak Bhavan, 9 Bahadur Shah Zafar Marg NEW DELHI 110002	2323 7617 2323 3841
Eastern :	1/14, C.I.T. Scheme VII M, V.I.P. Road, Kankurgachi KOLKATA 700054	2337 8499, 2337 8561 2337 8626, 2337 9120
Northern :	SCO 335-336, Sector 34-A, CHANDIGARH 160022	260 3843 260 9285
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